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mineral aggregate transportation study



SUMMARY



INDUSTRIAL MINERAL
BACKGROUND PAPER 1(a)


prepared for:



Ministry of
Natural
Resources

Ontario

by: **PEAT MARWICK & PARTNERS
M. M. DILLON LIMITED**



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Industrial Mineral Background Paper 1(a)

Mineral Aggregate Transportation Study

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Prepared by
PEAT, MARWICK AND PARTNERS
and
M.M. DILLON LIMITED

December 1980



Ministry of
Natural
Resources

Hon. James A. C. Auld
Minister

Dr. J. K. Reynolds
Deputy Minister

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For more detailed information on the Mineral Aggregate Transportation Study, reference should be made to the Final Report, IMBP 1, 133 pp. (price \$10.00).

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Mineral Aggregate Transportation Study

Preface

The objective of the Ministry of Natural Resources is to ensure that aggregate resources are available for the future needs of all Ontarians. It must be recognized that aggregate deposits are a finite resource distributed unevenly throughout the Province based on events from glacial and pre-glacial times. The result is that aggregate resources are concentrated in communities such as Uxbridge, Caledon and Halton Hills where today there is a high level of extraction and in such areas as the County of Grey where future extraction activities may converge.

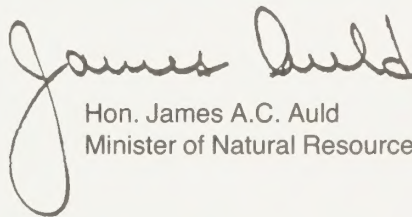
This publication represents the culmination of two years of Ministry funded research undertaken by consultants. I commissioned this research to investigate more remote, alternate sources of aggregate (such as in Grey) as possible future sources of supply to meet the projected demands in southern Ontario.

Transportation costs frequently form the major portion of the delivery price of aggregate originating from existing relatively close-to-the-market sources. It is important that the Government and the people of Ontario understand fully, both the financial and environmental implications of such a shift in supply sources.

In summary, the study indicates that, while Grey County contains one of the largest remaining reserves of sand and gravel in Southern Ontario, transportation of this material today is not economically feasible or environmentally desirable if the material is moved by either rail or road. Water haulage in combination with other modes of transport is even more unattractive from Grey County.

I am pleased to note the supplementary benefit of this study that the data produced can be used to analyze other transportation problems and can be applied to other bulk commodities. The study provides basic cost factors and data for the analysis of rail, water, and truck transportation of bulk commodities which should prove useful in a wide range of studies.

By the provision of this information to the public and to other arms of Government, I sincerely hope that we can all be better informed and hence more effective in achieving the best possible of all futures for Ontario.



Hon. James A.C. Auld
Minister of Natural Resources

Peat Marwick and Partners
M. M. Dillon Limited

Mineral Aggregate Transportation Study

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October 22, 1980

Dr. T.P. Mohide
Director, Mineral Resources Branch
Ministry of Natural Resources
Whitney Block
Queen's Park
Toronto, Ontario

Dear Sir:

Mineral Aggregate Transportation Study

We are pleased to submit our report of the Mineral Aggregate Transportation Study. This study has been one of a series of research projects carried out by the Ontario Ministry of Natural Resources with the objectives of achieving the most effective management of Ontario's mineral aggregate resources and ensuring a continuing security of supply.

The study investigated several options for attaining these objectives in terms of costs, quality of service and environmental impacts.

The results of the study are presented at three levels:

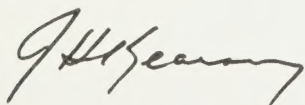
- o The Summary highlights the major findings and conclusions of the study.
- o The Final Report describes the methods and results of the study in more detail.
- o The Technical Appendix contains the background data and detailed descriptions of the various study tasks and is available to those who are interested in specific details or further research on the subject.

We wish to thank the members of the Advisory Committee, the staff of the Ministry of Natural Resources and of several other Ontario ministries, the municipalities, the carriers, industry associations and all the individuals who made valuable contributions to the study by offering advice, information and cooperation.

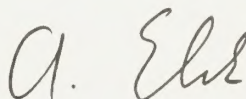
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The Consultants wish to acknowledge the valuable help provided by the members of the Advisory Committee and by many organizations and individuals. Whereas the data and conclusions contained in this report were developed by the Consultants the advice of those who contributed to the Study assisted greatly in the completion of the project. The following is only a partial list of those who provided assistance:

The Aggregate Producers' Association of Ontario and producers who responded to the survey

The transportation carriers

The staff of Provincial Ministries

The staff of Municipal government offices

OVERVIEW

Background

The Ontario Ministry of Natural Resources commissioned the Mineral Aggregate Transportation Study to examine the feasibility of supplying mineral aggregates to major urban centres from remote sources.

Toronto, London, Windsor and Sarnia were chosen as representative urban areas for the study. More than one third of the total mineral aggregate volume produced in Ontario is consumed in these four areas. Among these, the Toronto and London areas have substantial high quality aggregate resources. Both areas have enough possible resources to last for several decades, even if a significant part of these resources could not be accessed for environmental or other reasons.

Why is the Ontario Government then concerned with the potential need for transporting aggregates from remote sources?

The reasons for the concern are the effects of mineral aggregate extraction and distribution on the land, on the people and on their environment.

Aggregates are extracted from land which otherwise might be used for agriculture. Some production sites have been a source of annoyance to adja-

cent residents. As well, trucks hauling millions of tonnes of sand, gravel or crushed stone often cause congestion, noise, dust and safety hazards. This has given rise to strong opposition by local residents to the licensing of new pits or quarries in many parts of Ontario.

Hence, very few new licences were granted in the Toronto and London areas in recent years while the consumption of aggregates continued to deplete the existing licensed sources.

If no new licences were granted in the future, the existing licensed resources would be depleted by the early 1990's in the London area and around the year 2000 in the Toronto area.

A solution must be found therefore to secure the supply of mineral aggregates to the urban areas. Aggregates are vital to construction and it is estimated that in Ontario, one job in ten depends directly or indirectly on their availability.

Transportation of aggregates from remote sources is one of the often proposed solutions to the problem. It is reasoned that the effects of aggregate production and distribution on people and on the environment are less in cer-

tain geographic areas than in others. If that was found to be true, mineral aggregates should be produced in such areas and transported to the markets by the most effective means, provided that costs are acceptable.

Two areas were selected as representative of potential future sources of supply:

- The Saugeen area, which includes parts of Grey, Huron and Bruce Counties. The area has a large supply of sand and gravel.
- Manitoulin Island. The island has ample supplies of limestone.

The purpose of this study was to find the most effective means of transportation from the selected source areas to the selected markets, and to determine their costs and impacts. The long distance transportation option was then compared with other possible solutions to the conflict between the need for aggregates and the protection of the natural and social environment.

Truck on dusty road



Major Conclusions

These are the major conclusions of the study:

- Long distance transportation of mineral aggregates would increase the price of the delivered products substantially. For example, the average price of delivered aggregates in the Toronto area was \$4.55 per metric tonne in 1979. This price would increase by more than 50 percent to at least \$7.00 if the material was brought to Toronto by rail from the Saugeen area. The price increase would be even higher if the aggregates were transported from a greater distance, such as Manitoulin Island, or by other methods of transportation, such as trucks or ships.
- Even the minimum price increase would cost the Toronto area consumers approximately \$100 million annually. The rail transportation system would require additional capital investments in excess of \$400 million over the investments required for a system of continuing local supply and would consume almost twice as much fuel as the local supply system.
- For the London area, long distance rail haul would almost double the price of aggregates: it would increase from \$3.90 to \$7.60 per tonne. This would cost London consumers an additional \$20 million annually and require an initial investment of \$90 million.
- Windsor and Sarnia already rely on long distance transportation for the supply of crushed stone. The delivered price of crushed stone in these areas is presently in the broad range of \$7.00 to \$8.00.
- The impacts of aggregate production sites on agricultural land and on the natural environment would not be reduced significantly by moving production further away from the population centres. Provincial policies related to the rehabilitation of aggregate production sites and local licensing procedures already prevent most of the harmful effects of aggregate extraction that have occurred at some locations in the past. As long as similar principles of protection are applied throughout Ontario the impacts of aggregate production would not be much more severe in one area than in another.
- The numbers of local residents affected by the extraction and associated transportation of aggregates near the production sites would be smaller in a remote source area. However, the impacts on the communities may not be less because of the concentrated nature of the operations. In addition, many people would be affected by rail line relocation and by the heavy traffic on the rail lines. For example, between Saugeen and Toronto rail traffic would increase from a few short trains per week to 48 long trains per day.
- The only significant reduction of impacts that could be achieved through the long distance transportation of mineral aggregates would be a reduction in the harmful effects of trucking in the Toronto area. The rail receiving terminals could be located adjacent to Toronto's freeway network to make it possible for distribution trucks to move directly onto the highways without disturbing people along local roads. This is the major advantage that would have to be weighed against the costs of a long distance transportation system.
- The question must be asked whether the harmful effects of the trucking of aggregates on local residents could not be reduced by other means? Could the same results be achieved at substantially lower costs?
- The following measures could significantly reduce the impacts of trucking:
 - Construction of new access roads between aggregate extraction sites and major roads.
 - Giving greater recognition in the Ministry of Transportation and Communication's municipal roads subsidy program for improving municipal roads used for aggregate haulage.
 - Designating certain routes for aggregate hauling.
 - Enlarging the road surfacing program so that all roads used for significant aggregate haulage would be hard surfaced.

Trucks affect other motorists



- Recognizing the special requirements for aggregate traffic in road improvement programs to minimize interference with other traffic; truck climbing lanes and improvements at intersections are examples of this.
- Maintaining and enforcing regulations related to the sizes, weights and speed of aggregate trucks.
- Considering new legislation to provide for additional control over the movement of aggregate vehicles to minimize the aggravation to adjacent residents and other motorists.
- These measures could improve conditions in all supply areas, including those selected for this study. In contrast, long distance transportation may not always achieve equal results since a freeway network similar to that of the Toronto area is required to reduce the disturbance caused by aggregate trucks. For example, if rail distribution terminals were located in the London area, the harmful effects of aggregate trucking near those terminals would be greater than the effects of trucking near existing aggregate production sites, since the latter are generally dispersed throughout the area.
- Significant volumes of mineral aggregates are presently supplied to Windsor and Sarnia from sources in the United States. Most of these aggregates consist of crushed stone shipped from Michigan by water. The study showed that the stone could be supplied to Windsor and Sarnia from Manitoulin Island instead of the United States at approximately the same prices. However, only a large production and shipping facility would be economically viable.

Truck on highway



STUDY OBJECTIVES

Previous Studies Carried Out by the Ministry of Natural Resources

The Ontario Ministry of Natural Resources has carried out a series of studies in recent years to examine the availability of mineral aggregates in various regions of the Province, to forecast future needs, to identify alternatives for supply, and to develop policies for resource management.

Among these, the Ontario Mineral Aggregate Working Party provided advice and assistance to the Ontario Government in 1975/76 on mineral aggregate policies. Members of the Working Party included representatives of the Provincial and local governments, the aggregate industry, and the public.

In total, 64 recommendations were made by the Working Party. Several of these recommendations concerned the need for further research, including:

- the development of more precise forecasts for the demand for mineral aggregates
- detailed examination of the most effective methods of transportation over a wide range of distances by all feasible transportation modes.

Objectives of This Study

Acting on the recommendations of the Ontario Mineral Aggregate Working Party, the Ontario Ministry of Natural Resources commissioned the present study to meet the following objectives:

- To forecast the future demand for mineral aggregates in four typical market areas of Ontario: Toronto, London, Windsor and Sarnia.
- To reconcile these demands with projected supplies in the areas under study.
- To estimate the additional materials that will have to be supplied by long distance transportation or other means.
- To evaluate various options for the transportation of mineral aggregates to the selected market areas.
- To indicate the most effective alternatives, considering costs and environmental factors.
- To determine the transportation and handling costs that would have to be added to the price of aggregates if production close to markets became infeasible.

Several other areas of research, not originally specified in the Terms of Reference, were also addressed in broad terms in the study:

- the feasibility of the underground mining of stone,
- the potential for substitute materials,
- the continued utilization of local supplies, as compared with the option of long distance transportation,
- reduction of demand resulting from higher aggregate prices.

DEMAND AND SUPPLY AREAS

Four densely populated urban areas were selected for study:

- Toronto
- London
- Windsor
- Sarnia.

The study areas are shown in Figure 1.

Two supply areas were selected for the evaluation of supply and transportation systems:

- The 'Saugeen' area, which includes parts of Grey, Huron and Bruce Counties, as a source of sand and gravel.
- Manitoulin Island, as a source of stone.

These are also shown in Figure 1. Although the results presented in this Report are related to these supply and demand areas, the data and information developed in the Study can be easily applied to other combinations of sources and consumption centres elsewhere.



THE USE OF AGGREGATES

Classification of Mineral Aggregates

There are two major categories of mineral aggregates:

- sand and gravel
- crushed stone.

Sand occurs in combination with gravel; both are excavated from open pits. They consist of a mixture of coarse and fine material. Fine particles are defined as smaller than 6 millimetres. Coarse gravel may be crushed to desired sizes.

Stone is produced in quarries where rock is blasted and crushed to required sizes. Crushed stone usually contains about 25% fine particles as a result of the crushing. Most of the stone used in Ontario is produced from limestone or dolostone.

The difference between a gravel pit and a stone quarry is the consistency of the material. In the former, the material is deposited in an 'unconsolidated' form, in the latter, the material is found in a 'consolidated' form.

Crushed stone is interchangeable with gravel for many applications. The most important specifications are those of particle sizes and their proper proportion, though physical and chemical properties are also important.

Typically concrete and concrete products require 55% coarse and 45% fine aggregates. The several materials used in road construction require approximately 45% coarse and 55% fine aggregates. It was found that, in total, each of the four study areas uses approximately 45% coarse and 55% fine aggregates.

Categories of Use

The primary use of mineral aggregates is in construction, where the principal end uses are:

- *Concrete and concrete products.* Mineral aggregates are the principal ingredients of concrete, together with cement. The main component used in the manufacture of cement is limestone, which is also a mineral aggregate.
- *Road construction.* Mineral aggregates are used in their natural granular form for embankments, backfill, drainage facilities, road base, and as ingredients in asphalt and concrete.

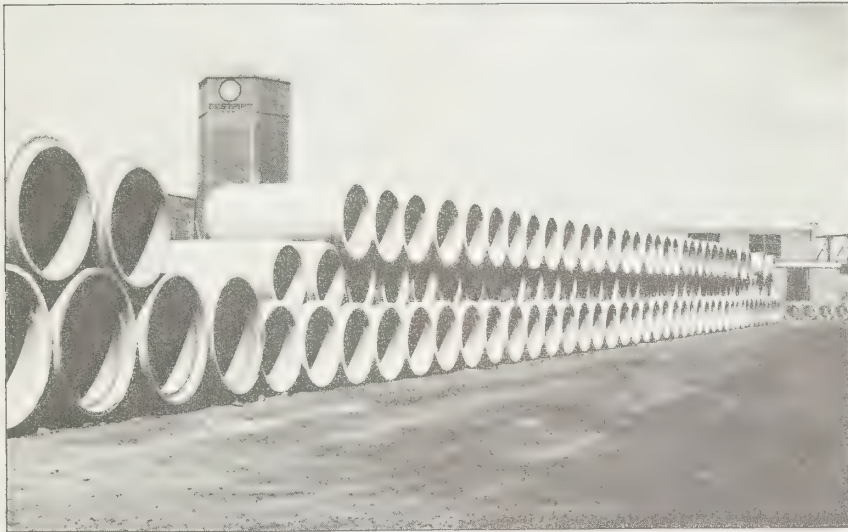
- *Engineering construction.* Aggregates are needed for a wide variety of construction applications, such as airports, marine docks, dams, parking lots. In addition to their use in the form of concrete and asphalt, they are also used in large quantities in their natural form as foundations, fill material, or backfill for such services as sewers and water mains.
- *Residential and non-residential building construction.* In addition to being used in the form of concrete and concrete products in building construction, mineral aggregates are used in the foundations of buildings and driveways, as ornamental stone and for fill.
- *Railroad ballast.*
- *Industrial applications.* Special mineral aggregates, such as limestone and dolostone are used for various industrial processes, particularly in the steel and chemical industries.

Gravel Pit





*Use of aggregates:
road construction*



*Use of aggregates:
concrete pipes*



Stone quarry

THE DEMAND

During the past 20 years, the consumption of mineral aggregates in Ontario has increased at an average annual rate of 1.6%. As shown in Figure 2, the growth has been uneven. After a fast growth until 1965, consumption has levelled off in a range of 115 to 135 million metric tonnes per year.

In order to predict future demand for aggregates, historical data were examined in detail and separate forecasts of consumption were prepared using different methods for four end uses:

- **Road Construction.** Some 40% of all aggregates are used for this purpose in Ontario. Modified designs, due to price increase and significant efforts at recycling, indicate a reduction in the use of aggregate for road construction.
- **Residential Building Construction.** The housing industry will decline over the next two decades due to declining birth rates; its share of aggregate consumption, though not large, will decline as well.

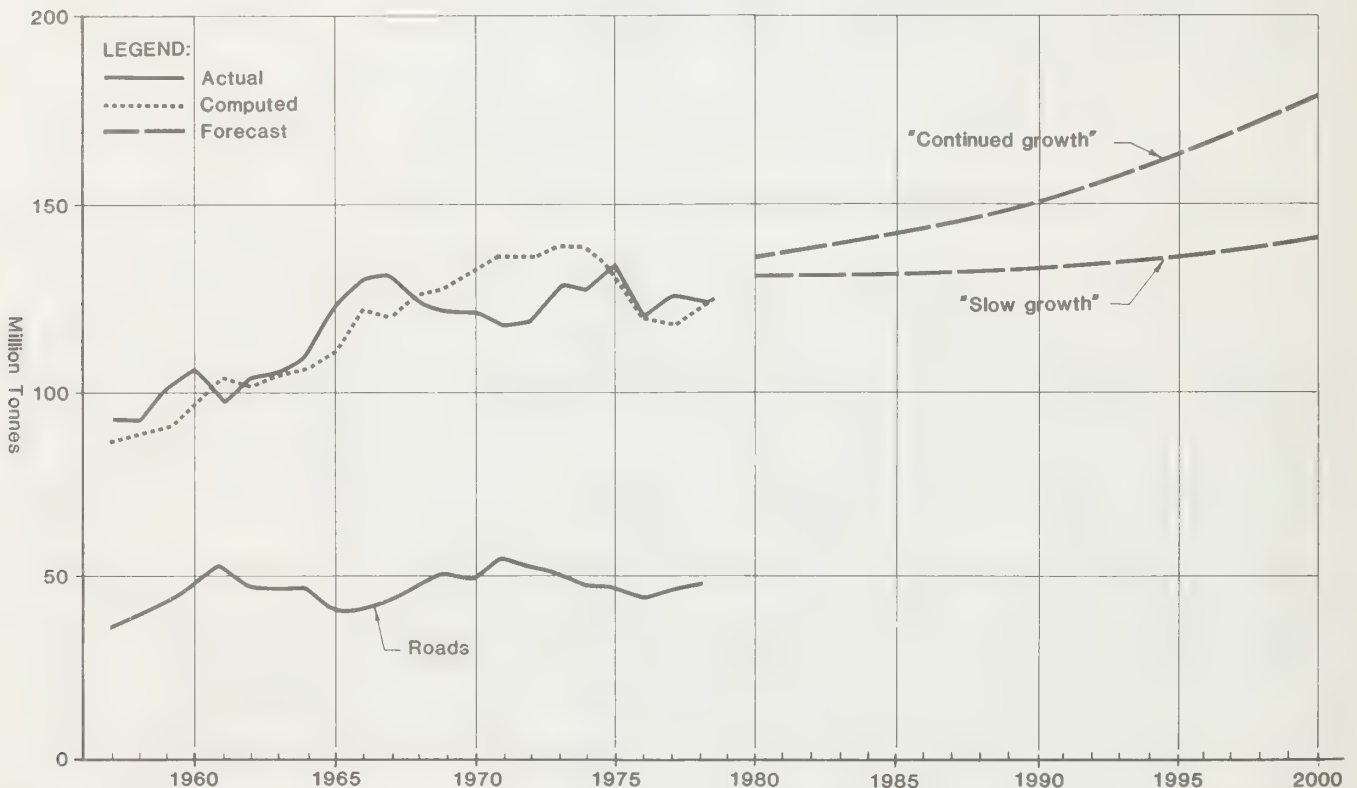
- **Concrete Production.** This significant user of aggregates is very closely related to economic activity and hence the Gross Provincial Product. Projections for the future indicate resumption of growth and an increase in concrete production.
- **Non-Residential Building and Non-Road Engineering Construction.** This category was defined to include all other uses of mineral aggregate. The activity in these areas, and hence aggregate consumption, is also related to the Gross Provincial Product and is predicted to resume growth.

The amounts of mineral aggregates used for Provincial and municipal road construction were forecast by direct methods, based on Needs Studies and Provincial/municipal plans. Aggregates required for the construction of subdivision roads and for residential building construction were forecast by relating future developments to projected changes in population and employ-

ment. Concrete production and the use of mineral aggregates for all other purposes was forecast by developing two econometric models. These linked aggregate consumption to the Gross Provincial Product and to changes in the Gross Provincial Product during the four preceding years.

Figure 2 indicates that under the assumption of continued economic growth the annual consumption of mineral aggregates may be 40% higher in the year 2000 than today. This estimate was based on economic growth forecasts made by the Economic Council of Canada, projected into the longer term. Forecasts of mineral aggregate demands, under this assumption, broken down by area, are summarized in Figures 3 to 6.

Figure 2 also indicates that under more pessimistic projections of economic growth, the annual consumption of mineral aggregates is forecast to remain approximately at present levels.



Past history shows that even in times of no economic growth there is significant construction activity and a significant demand for aggregates. They are used for replacement, renewal and rebuilding of existing plant.

Potential substitute materials were reviewed in detail. Because of the current low price of aggregates (less than 1/2 cent per kilogram in most regions) it is very doubtful whether any other product could be used which would have a significant impact on the market.

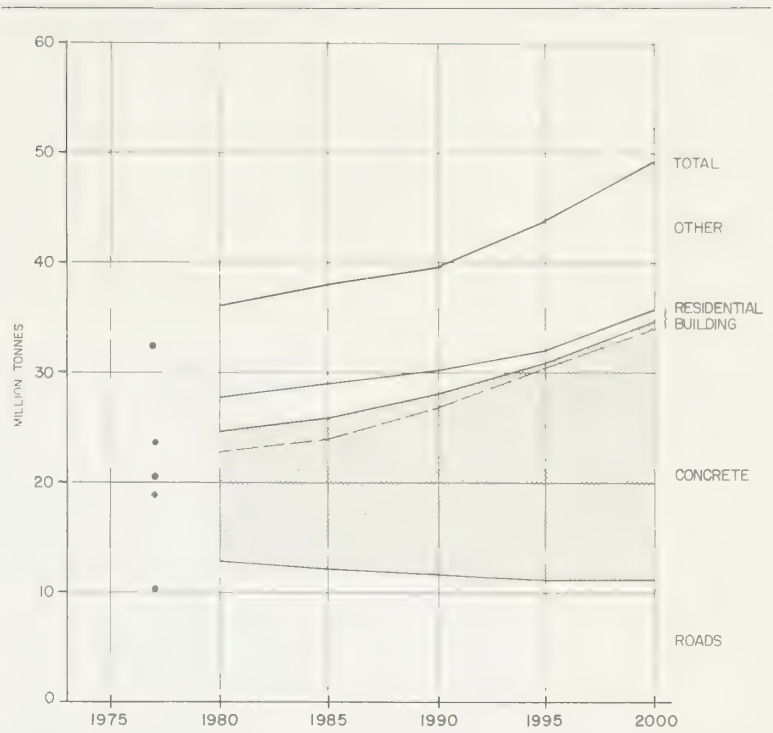
Recycling of aggregate will become more prevalent in the future but almost completely in road construction. It is a major activity being pursued by the Ministry of Transportation and Communications and will become more popular with other road authorities. However, the major impact will be in resurfacing. Consumption for that use will likely drop by more than half but resurfacing is usually less than 10% of a road program and, therefore, the reduction in aggregate demand resulting from recycling is not expected to be significant.

Where aggregates are currently plentiful, the change of the road surface reflects this. If aggregate prices were to increase as a result of long distance transportation, new road designs would be adopted that use less aggregate. Such designs are already being used in the Windsor and Sarnia areas where aggregate prices are high. In the Toronto and London areas increases in aggregate prices ranging from 50 to 100 percent would cause a 5 to 10 percent reduction in the overall amount of aggregates consumed in the areas.

It can be expected, therefore, that a substantial increase in aggregate prices caused by long distance transportation to the Toronto and London areas would cause a total reduction of less than 15 percent in the forecast total mineral aggregate demand shown in Figures 3 and 4.

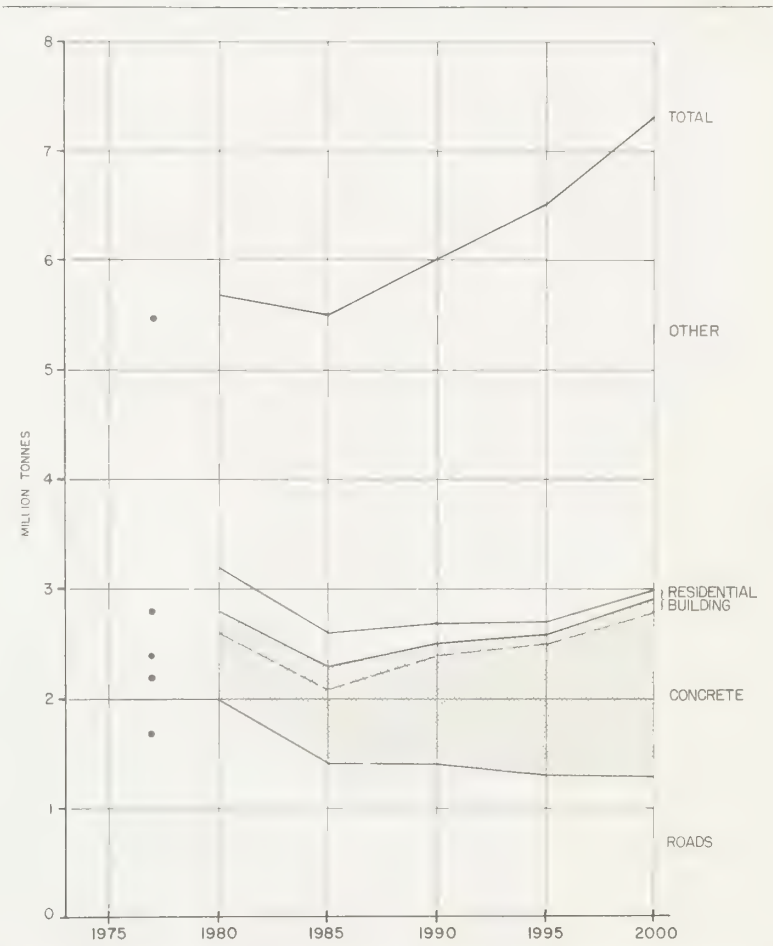
The study has, therefore, determined the continuing need for supplying large volumes of mineral aggregates regardless of the rate of future economic growth.

The various ways in which these volumes of aggregates can be supplied to the Toronto, London, Windsor and Sarnia areas and the impact of the various supply methods are summarized in the next chapters.



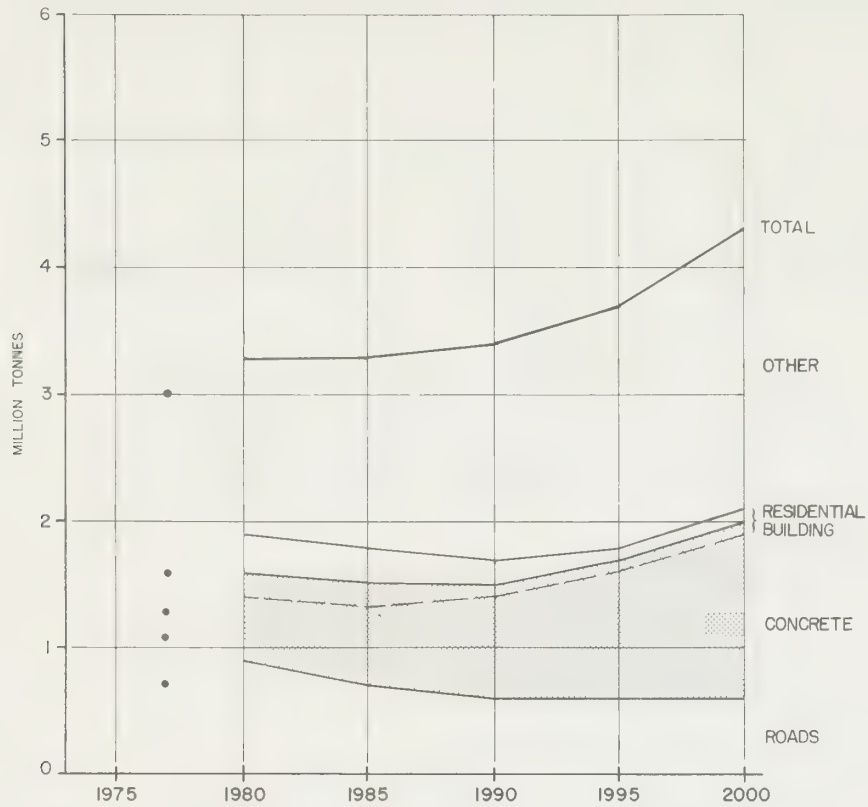
AGGREGATE FORECASTS - TORONTO AREA

3



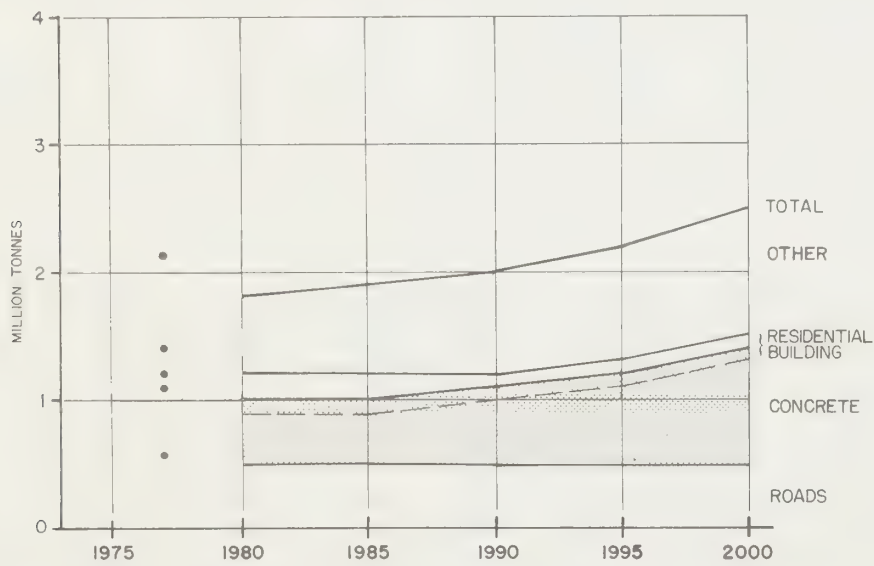
AGGREGATE FORECASTS - LONDON AREA

4



AGGREGATE FORECASTS - WINDSOR AREA

5



AGGREGATE FORECASTS - SARNIA AREA

6

SUPPLY OF THE TORONTO AREA

Possible Resources

The Toronto area consumed 33 million metric tonnes of mineral aggregate in 1977. These were supplied from numerous producers located relatively close to the markets. Production of over one half of the total is in three general areas:

- Halton Hills, west of Metropolitan Toronto
- Caledon, northwest of Metropolitan Toronto
- Uxbridge, northeast of Metropolitan Toronto

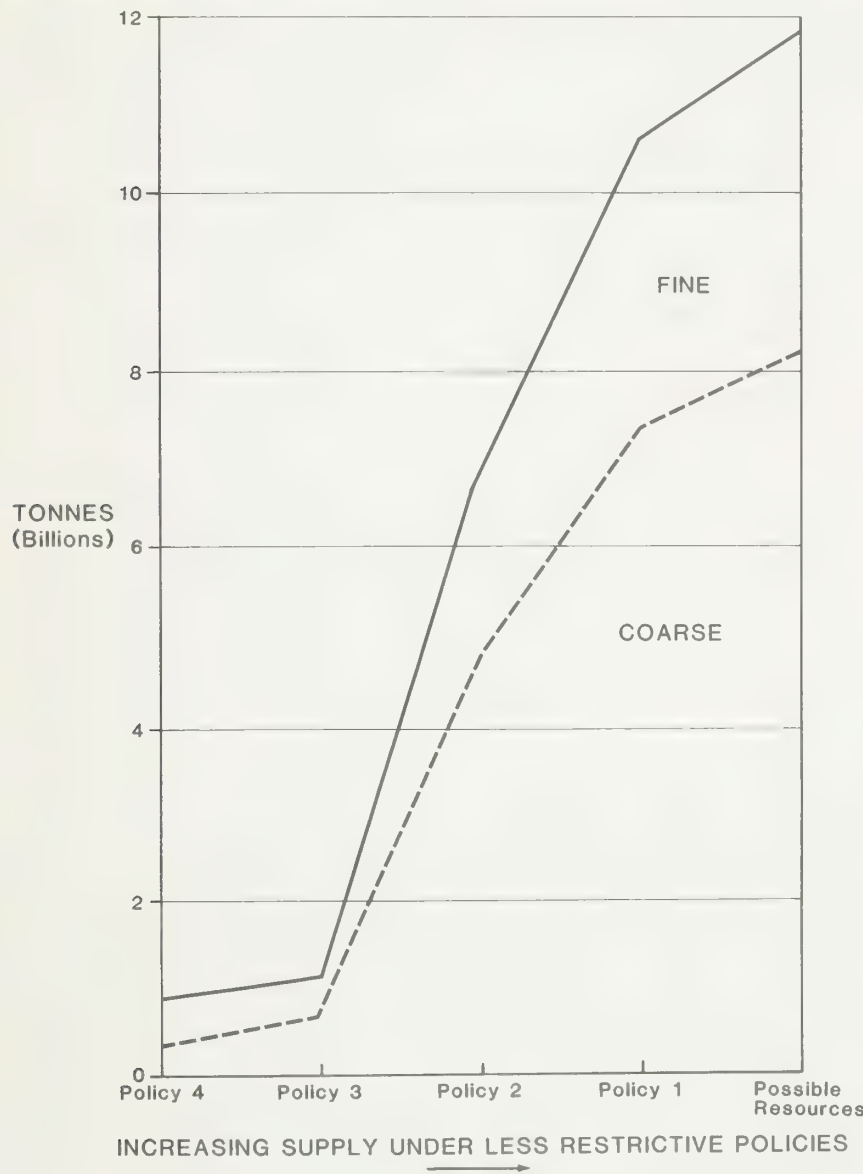
Reserves are extracted, processed and hauled to the consumer almost completely by truck. Rail haul services a declining proportion of the market, currently 7%.

Licensed reserves in the Toronto area and at locations presently supplying the area are estimated at 1.1 billion tonnes.

Figure 7 shows the possible mineral aggregate resources in the Toronto area under a range of policies related to community impact, land use and environmental concerns. The policies

- indicated in Figure 7 are samples drawn from a wide range of potential policies. In broad terms they imply the following restrictions:
- Policy 4: No new licences issued.
 - Policy 3: Licensing restricted to areas designated for aggregate extraction in official plans. Significant setback requirements and no licences where Class 1 and 2 agricultural land is predominant.
 - Policy 2: Changes in official plans and zoning permitted. Setback requirement somewhat relaxed. No agricultural land restriction. Arterial road must be available.
 - Policy 1: Least restrictive setback requirements, but severe requirements in the Niagara Escarpment area.

Figure 8 compares the forecast consumption of mineral aggregates with the available possible resources under various policies. The assumption underlying this forecast was continuing economic growth. The diagram indicates a complete depletion of the presently licensed resources after the year 2000. However, if only a small part of the possible resources available under Policy 2 were licensed, the supply of mineral aggregates from within the Toronto area would last well into the next century.



Supply Options

In order to ensure the continuing availability of mineral aggregates required by Ontario's industries, licensing of new sources of aggregates or the provision of alternate sources of supply must thus be considered in the near future. This study examined two basic choices for supplying the necessary amounts of aggregates to the Toronto area:

- Transport aggregates over considerable distances from source areas where suitable aggregates are available in large quantities and where some of the environmental impacts may be smaller than in the Toronto area.
- License new production sites in existing production areas.

A third option was also studied, that is to extract stone from underground mines developed in the Toronto area. However, this option was only consid-

ered as supplementary to either of the other two because underground mining of stone does not provide adequate fine materials.

The following long distance transportation options were evaluated:

- Rail transportation – from the Saugeen to the Toronto area
- Truck transportation – from the Saugeen to the Toronto area
- Pipeline transportation – from the Saugeen to the Toronto area
- Water, water/rail and rail transportation – from Manitoulin Island to the Toronto area.

Each option will be briefly described, showing:

- the estimated prices of mineral aggregates,
- the required investments,
- fuel consumption.

The description and partial evaluation of each system will be followed by a comparison of the options in terms of the following remaining criteria:

- impact on the communities
- impact on agricultural land
- impact on the natural environment
- flexibility of service
- reliability of service.

The long distance transportation options will then be compared with the alternative of continuing the present system of local supply.

Rail Transportation from the Saugeen to the Toronto Area

Several transportation methods were compared for an annual volume of 40 million metric tonnes of sand and gravel. This corresponds to the 'continued growth' forecast of the Toronto area aggregate consumption in 1990 when approximately one half of the presently licensed reserves would be depleted. At that time alternate sources of supply would have to be considered to prevent a complete depletion of supplies around 2000 and the shortages that would develop in the meantime.

It was found that unit trains dedicated to aggregate traffic would be the most economical means of transportation. The trains would consist of four diesel locomotives and 80 cars, and each train would carry 7230 tonnes of aggregate. In each direction 24 trains would be required. If present rail lines were used, their traffic would be split between C.P.'s and C.N.'s lines. The lines are shown in Figure 9.

The effects of 12 unit trains per day, in each direction, on each of the two lines passing through communities presently not disturbed by more than a few trains per week, is serious. Costs would be high due to the need for many grade separations. To alleviate this problem, it appears financially sensible and more effective to relocate certain parts of one rail line to avoid all built-up

locations and assign the entire aggregate traffic to it. This line would logically be the CP line from Durham to Brampton. The line would have to be double-tracked for its entire length from the Saugeen area to Toronto to carry the entire traffic.

If the most efficient rail transportation system were implemented, the average delivered price of sand and gravel in the Toronto area would be at least \$7.00 per tonne at 1979 price levels, compared with the present average price of \$4.55: an increase of \$2.45 or 53% over 1979's price. This is, however, only the lower limit of the potential price increase since it implies:

- that the railways would not charge more than the rates that would provide them with a contribution to fixed costs that is equal to the average contribution that they obtain from their profitable traffic
- that Government would rebuild the rail line that would carry the aggregate traffic and build grade separations; because of the lower rates of return required by Government this would result in lower costs than the investments made by the railways.

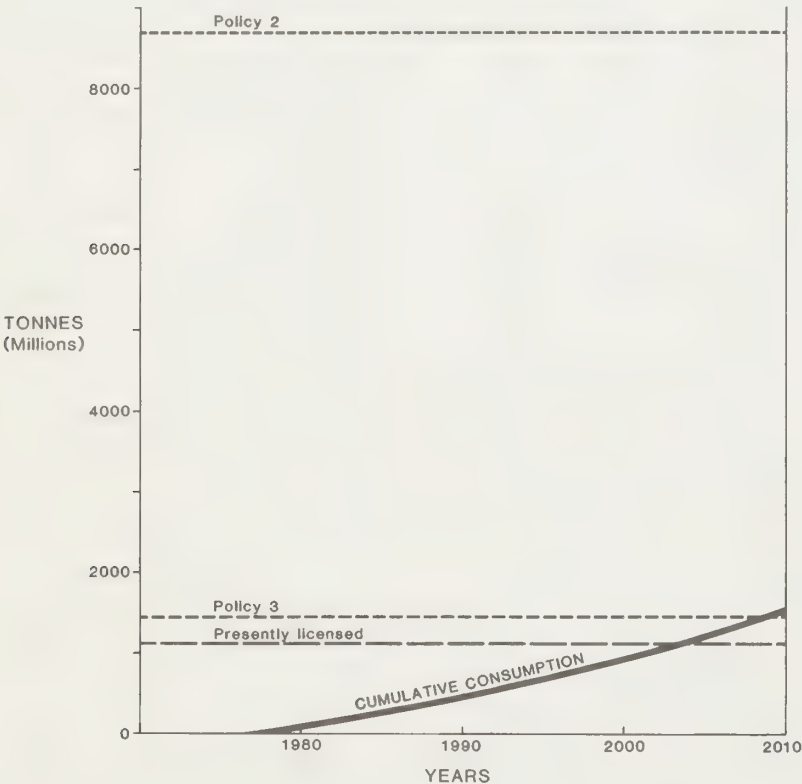
This method of long distance transportation would thus cost the consumers at least \$100 million every year over and above the cost of aggregate produced by present methods locally.

The minimum rail rates estimated in the Study are shown in Figure 10. These rates contribute to the total delivered aggregate price of \$7.00 per tonne.

The rail transportation system would require a total additional investment of approximately \$410 million over and above the investments that would be required if the supply of aggregates continued from local sources. The additional investment includes the partial relocation and double-tracking of the rail line, the construction of grade separations, 18 train sets costing \$8 million each, and investment in large rail loading and receiving terminals.

There would be two large rail loading terminals in the Saugeen area and four receiving terminals in the Toronto area. The latter would be located adjacent to freeways in order to minimize the impacts of distribution trucks. Such large terminals are not being used at present for aggregate transportation. They are used, however, in the iron ore and coal industries and would have to be used for aggregates if 40 million tonnes were to be moved in an efficient manner.

The long distance rail transportation alternative would consume approximately 110 million litres of diesel fuel per year, compared with an estimated 60 million litres that would be consumed if the present system of local supply was continued.

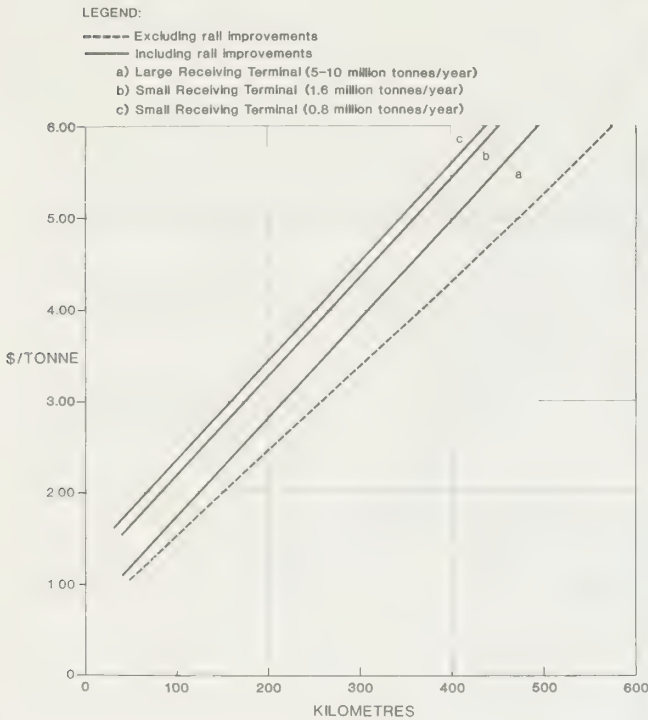




RAIL ROUTES - SAUGEEN TO TORONTO

Aggregate train





ESTIMATED MINIMUM RAIL RATES (1979 \$) 10

Truck Transportation from the Saugeen to the Toronto Area

The present highway system could not provide the capacity for the trucks required to haul 40 million tonnes of aggregates from the Saugeen area to Toronto. A new freeway, designated to aggregate traffic would be required.

During peak hours, the estimated number of trucks travelling on this freeway in both directions combined would be 1,440, or approximately one truck every two and a half seconds.

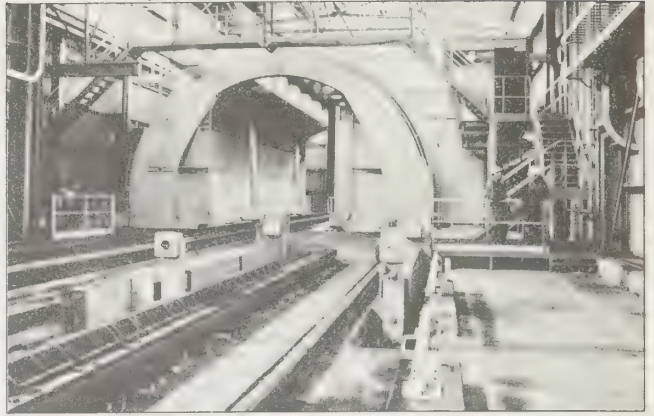
Transportation by truck was found to be much more costly than transportation by rail. The average delivered price of aggregates was estimated to be \$9.95 per tonne at 1979 price levels, well over twice the present average price.

Truck rates estimated in the Study are shown in Figure 12. Truck transportation costs are compared with rail transportation costs below.

ESTIMATED AVERAGE DELIVERED PRICES OF AGGREGATES SAUGEEN TO TORONTO AREA (\$/metric tonne)

	Rail	Truck
FOB stockpile	\$2.50	\$2.30
Loading terminal charge	.25	.25
Rail rate	2.16	—
Receiving terminal charge	.80	—
Truck to customer	1.15	7.40
	\$6.86	\$9.95
Government recovery		
For grade separations	.14	
	\$7.00	

Rail car dumper: turns car sideways



Large iron ore terminal: such terminals could be used for aggregate



The additional investment over and above that required for a system of continuing local supply was estimated to be approximately \$320 million, in terms of 1979 prices. This includes the cost of the freeway and the costs of approximately 4000 trucks that would be required to carry 40 million tonnes of aggregate annually, compared with only 1600 trucks required in a system of local supply. Each truck, carrying 35 tonnes of aggregate, would cost approximately \$80,000.

It was found that the entire capital and maintenance cost of the dedicated aggregate freeway would be paid indirectly by the truckers through Ontario fuel taxes. Thus the cost of the freeway would be passed on to the consumers through the truck rates, which are included in the price of delivered aggregates.

The fuel consumption for transporting 40 million tonnes of aggregates by truck over 160 kilometres, instead of an average distance of 35 kilometres in the local supply system, was estimated to be 240 million litres per year instead of 60 million litres. This additional amount of fuel would be sufficient to provide all the direct and indirect petroleum fuel requirements of a city of about 40,000 people.



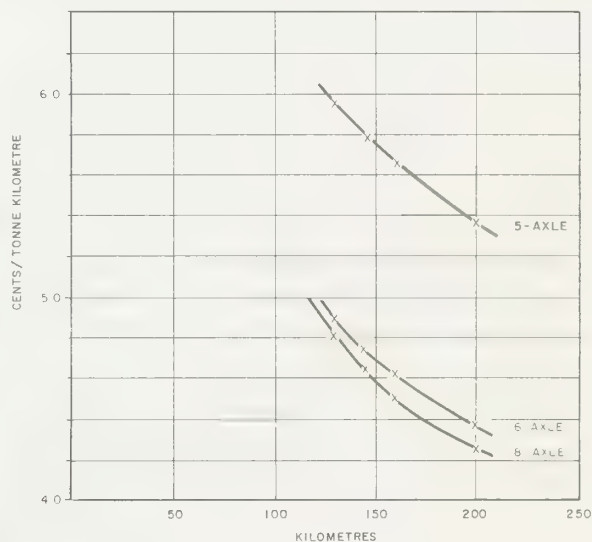
NEW TRUCK ROUTE - SAUGEEN TO TORONTO

11

Loading aggregate truck



Truck dumping aggregates



ESTIMATED TRUCK RATES (1979 \$)

12

Pipeline Transportation from the Saugeen to the Toronto Area

Long distance transportation of mineral aggregates by slurry pipeline, although comparable in costs with long distance trucking, was found to be infeasible at the present state of technology. The pipeline would have to carry particle sizes up to 50 mm in diameter which is several hundred times larger than the particle sizes of coal or iron ore transported by such pipelines today and 40 times larger than sand presently carried by a relatively short tar sand tailing pipeline in Alberta. Much more research and development would be required before a slurry pipeline could be built for the transportation of sand and gravel over long distances.

The water and energy requirements of pipeline transportation were also found to be excessive. An aggregate pipeline would require 13 times as much energy as equivalent rail transportation.

Water, Water/Rail and Rail Transportation from Manitoulin Island to the Toronto Area

Only stone can be mined on Manitoulin Island. This would not provide enough fine aggregates for the 45/55 percent coarse/fine aggregate mix required in the Toronto area. The 'natural' fine content of crushed stone is only about 25 percent. For that reason the Toronto area could not use more than approximately 9 million tonnes of stone from Manitoulin Island and the remaining 31

million tonnes of sand and gravel would still have to be transported from an alternate source.

Three methods of transporting Manitoulin Island stone to the Toronto area were considered, as shown in Figure 13:

- Transportation by ship all the way through the Welland Canal to marine terminals in the Toronto area
- Transportation by rail all the way from Little Current on Manitoulin Island to Toronto
- Transportation by a combination of ship and rail haul through a trans-shipment port near Midland on Georgian Bay.

The ships considered in the study were 220 metre (730 ft.) self-unloaders. These ships can carry 32,400 metric tonnes on the Lakes but only 26,700 metric tonnes through the Welland Canal because of draft restrictions.

Self-unloaders carry the unloading gear on board and therefore do not require elaborate receiving terminals.

The estimated prices of delivered crushed stone transported from Manitoulin Island to the Toronto area, are shown below at 1979 price levels. These prices are all substantially higher than the estimated average price of aggregate transported from the Saugeen area.

The supply of aggregates from Manitoulin Island to the Toronto area was rejected as a feasible alternative for the following reasons:

- Substantially higher costs than those of other options.
- Since less than 25% of Toronto's aggregate requirements can be supplied from Manitoulin Island, this alternative would only represent a partial solution to the supply problem. To supply larger amounts would

**ESTIMATED DELIVERED PRICES OF AGGREGATES
MANITOULIN ISLAND TO TORONTO**
(\$/metric tonne)

	Ship/Rail	All-Ship	All-Rail
FOB stockpile	\$2.25	\$2.25	\$2.25
Loading terminal charge	.45	.45	.30
Ship rate	1.40	5.65	—
Transfer terminal charge	.60	—	—
Rail rate	2.25	—	5.85
Receiving terminal charge	.85	1.00	.85
Truck to customer (average)	1.15	1.55	1.15
	\$8.95	\$10.90	\$10.40

Self-unloading ship



require the manufacturing of fine aggregates which would result in a substantial further price increase and would not provide a product that would be universally applicable for all uses.

- It would not be possible to ship the total aggregate requirements of 40 million tonnes to Toronto via the all-water route because of capacity limitations in the Welland Canal, the difficulty in accommodating the necessary termi-

nals and their associated truck traffic along the Toronto area waterfront, and the impacts of trucking near such terminals.

- The options involving rail transportation of Manitoulin Island stone would not offer any advantages over the transportation of aggregates from the Saugeen area with respect to community and environmental impacts along the rail lines and near the receiving terminals.

Comparison of Long Distance Transportation with Continued Local Supply from Surface Extraction

After having eliminated the pipeline and water transportation options the remaining options are:

- Rail transportation from the Saugeen to the Toronto area
- Truck transportation from the Saugeen to the Toronto area
- Continuing local supply from surface extraction
- Local supply from underground mining.

The long distance transportation options have already been compared with the option of continuing local supply in terms of costs, investment requirements and fuel consumption and were found to have significant disadvantages by each of these criteria. The options are now compared in terms of:

- Impacts on communities, agricultural land and the natural environment
- Flexibility and reliability of service.

The table below summarizes the results of the comparisons.



ROUTES FROM MANITOULIN ISLAND TO TORONTO 13

COMPARISON OF OPTIONS			
	Continuing Local Supply from Surface Extraction	Long Distance Transportation	
		Rail	Truck
	(1)	(2)	(3)
(i) Delivered Price – \$/tonne	4.55	7.00	9.95
(ii) Additional Investment – million \$	—	410	325
(iii) Community Impacts			
– Sources:	– Relocate 120 persons/yr. (free market)	– Relocate 30 persons/yr. (expropriate)	
– Line haul:	—	– Impacts along 125-km route	
– Distribution:	– Disruptive	– Better than (1)	
(iv) Impacts on Agricultural Land	Rehabilitation reduces impact	Source area: same as (1) Route: added impact	
(v) Impacts on Natural Environment	Impacts during years of production	Same as (1)	
(vi) Flexibility	Good	Somewhat better than (1)	Worse than (1)
(vii) Reliability	Good	Worse than (1)	Same as (1)
(viii) Petroleum Fuels – million litres/yr.	60	110	240

(a) Impacts on Communities, Agricultural Land and the Environment

In order to minimize the community impacts in the Saugeen area the extraction of aggregates and the associated operations would have to be properly planned and designed. To ensure that extraction could proceed in a planned manner in the future, at least 8000 hectares (20,000 acres) of land would have to be assembled. In the planned extraction scheme the excavated material would move from the pits to two large processing plants on private roads, without disturbing any local residents. For an annual production level of 40 million tonnes of aggregate approximately 30 persons would have to relocate each year as production progresses throughout the area.

The impacts of long distance rail and truck transportation on communities in the production area would be similar. Trucks in the Saugeen area would travel from individual production sites on private roads to a common point where the trucks would either deliver to the rail terminals or access the dedicated freeway.

If aggregate production continued in the Toronto area, the number of persons who would have to relocate would be approximately 120 per year. However, in the Toronto area the expansion of production would be dispersed and aggregate producers would probably

be able to acquire the required properties on the free market. Conversely, in the Saugeen area the production would be highly concentrated and to assemble the necessary land it would likely have to be expropriated.

All considered, the likely impacts of aggregate production on communities would not be less disruptive in the Saugeen area than in the Toronto area.

Both the rail and the truck transportation options would have significant impacts on local residents along the 120-130 kilometre transportation route. Some people would have to relocate because of rail line or road construction, others would be disturbed by the traffic. None of these impacts would occur in the case of continuing local supply.

The most significant difference between the long distance transportation option and the option of continuing local supply would be in the impacts of local trucking on residents in the Toronto area. These impacts include:

- noise
- dust
- traffic congestion
- perceived safety hazards
- property damage.

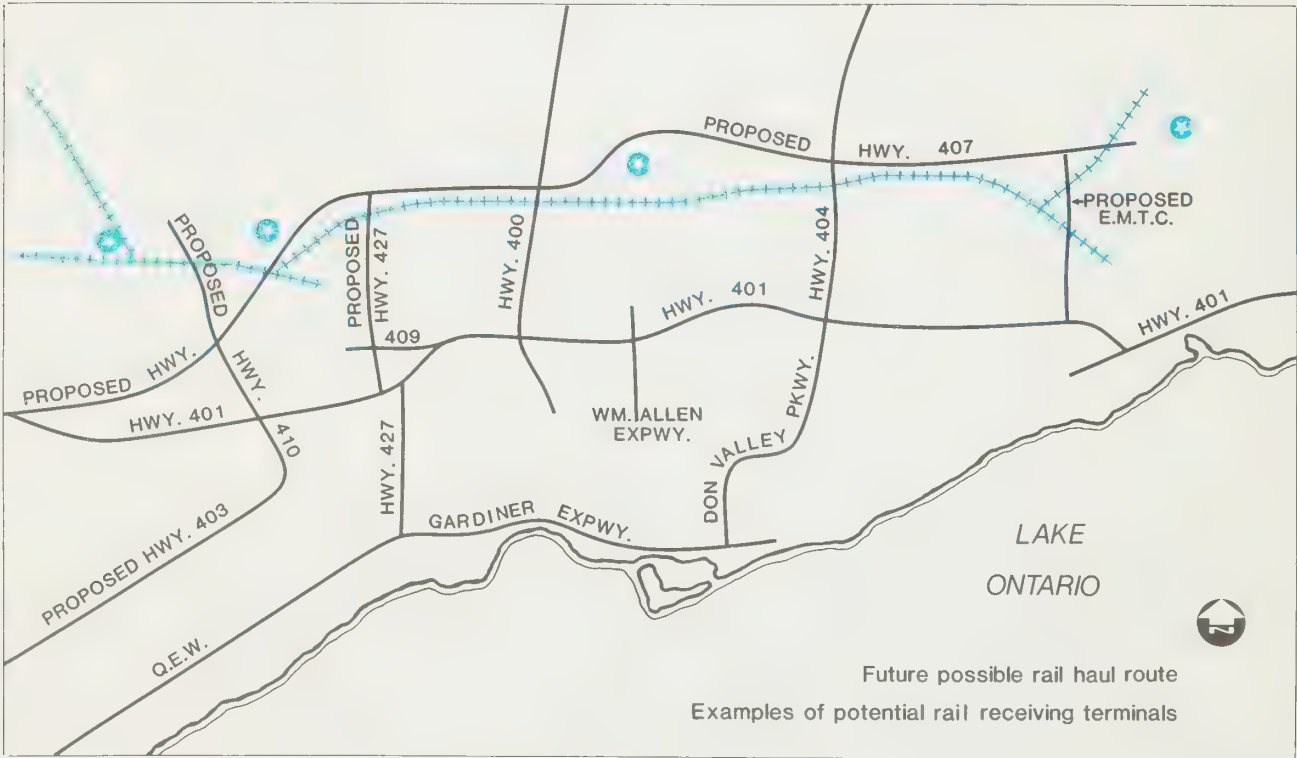
The rail receiving terminals would be located adjacent to the Toronto freeway system as shown in Figure 14. Distribution trucks from these terminals could access the freeways directly. Similarly, in the long distance trucking

option the dedicated aggregate freeway would be directly connected with the Toronto freeway system to minimize the disturbance on local roads. Thus, traffic currently hauling aggregate from the local supply areas to the major freeways would be eliminated. The final portion of the traffic from the freeway to the customer along local roads would, however, be the same in all cases.

With respect to impacts on agricultural land and on the natural environment there would be little difference between aggregate production in the Saugeen and Toronto areas. As long as similar criteria are used for licensing new production sites, the impacts would not be less severe in the Saugeen area than near Toronto.

It can be concluded that with respect to community, agricultural and environmental impacts the only significant advantage of the long distance transportation option over the option of continuing local supply would be the reduction of the harmful effects caused by the distribution trucks on the roads between the production sites and the freeway network.

However, if these effects could be reduced to the same extent by other means, all the advantages of the long distance transportation options would disappear. Examples of such means are provided in the last chapter of this Report.



(b) Service

The long distance rail transportation option would provide a slightly greater flexibility of service than the option of continuing local supply because of the somewhat shorter distances between the distribution yards and the customers. However, the differences would be small. On the other hand, the reliability of service would be significantly poorer because the system would have to rely on centralized facilities and on only one railway line as opposed to the large number of suppliers and truckers of a local supply system.

The long distance trucking option would provide a poorer flexibility of service because of the long transportation times. There would be no difference, however, in the reliability of service.

It can be concluded that the quality of service provided by the long distance transportation options would be generally worse than that provided by the option of continuing local supply.

Comparison of Long Distance Rail and Truck Haul

The comparisons indicated no advantages of long distance trucking of aggregates over rail transportation. Since truck transportation would be more costly, the rail option would be preferred.

The significance of the truck option is its role in representing a potential competing method of transportation to the railways and thus imposing an upper limit on the potential range of rates.

Underground Mining

A supplement to either long distance supply or to local supply from surface extraction could be underground mining of stone. Underground mining would eliminate several disadvantages associated with the surface extraction of aggregates:

- Mines can be located adjacent to freeways, so that the harmful effects of trucking on local roads could be significantly reduced.
- The plants associated with mining occupy much less land than surface production sites.
- The impact of the mines on communities and on the natural environment would be minimal since they would be located in heavily industrialized areas.

The major disadvantages of the underground mining of stone would be:

- A higher unit cost resulting in average delivered prices of \$5.95, compared with 4.55 for aggregate delivered from a pit or quarry, in terms of 1979 price levels.
- Since underground mining could not produce more than approximately 25 percent of fine aggregates it can only be regarded as a supplement to sand and gravel pits that would still have to provide the necessary fine aggregates.
- Since mineral rights would have to be acquired for underground mining the locations of potential mines would be restricted to large contiguous properties which are rare in urbanized areas.

If aggregate prices increased beyond the general inflation rate, underground mining may become a competitive source to supplement local supply.

SUPPLY OF THE LONDON AREA

The estimated possible resources that would be available to the London area under a range of licensing policies are shown in Figure 15. The same sample policies were used for this analysis as for Toronto. The possible resources are compared with the demand for mineral aggregates, as forecast under the assumption of continuing economic growth, in Figure 16.

Figure 16 indicates that the presently licensed supplies are expected to run out in the early 1990's and, therefore, licensing of new production sites is required to avoid a shortage of aggregates that could occur within the next few years. Generally, the supply situation in the London area is substantially tighter than in the Toronto area. With our present knowledge of possible aggregate resources, most of those that would be eligible for extraction under Policy 2 would have to be licensed if supplies were to last beyond the year 2000.

Supply Options

The options for supplying mineral aggregates to the London area were evaluated at a level of 6 million tonnes per year.

The options were:

- Rail transportation on existing rail lines from the Saugeen area.
- Truck transportation from the Saugeen area on existing highways.
- Continuing local supply from surface extraction.

Additionally, supply from underground mining was also examined in the London area.

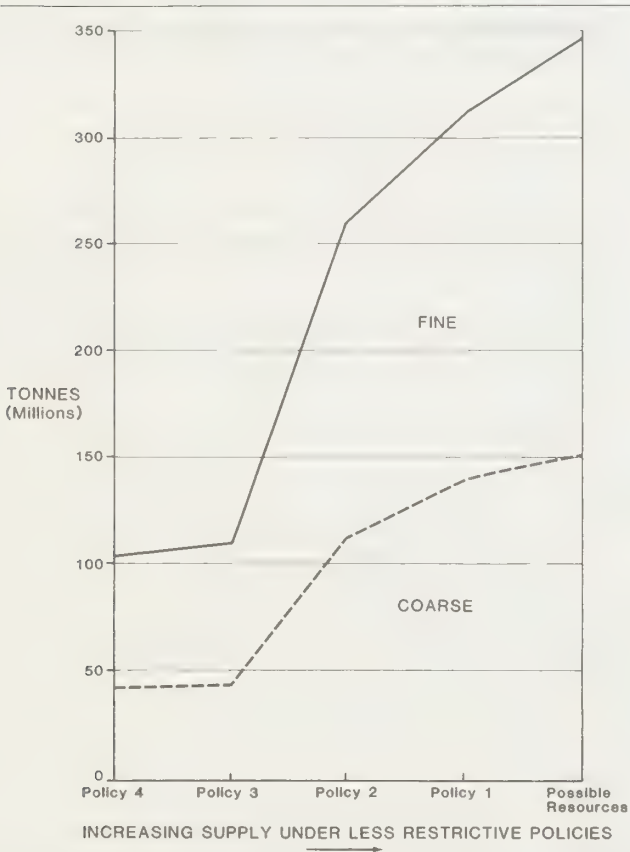
These options differ from those evaluated for Toronto in the use of transportation routes. The relatively small volume of aggregate traffic would not warrant the relocation of railway lines or the construction of a dedicated freeway. The transportation routes for the London area are shown in Figure 17.

Many of the conclusions reached for the London area are similar to those reached for the Toronto area. It would be repetitious to describe them in detail and only the differences between the Toronto and London areas are highlighted below.

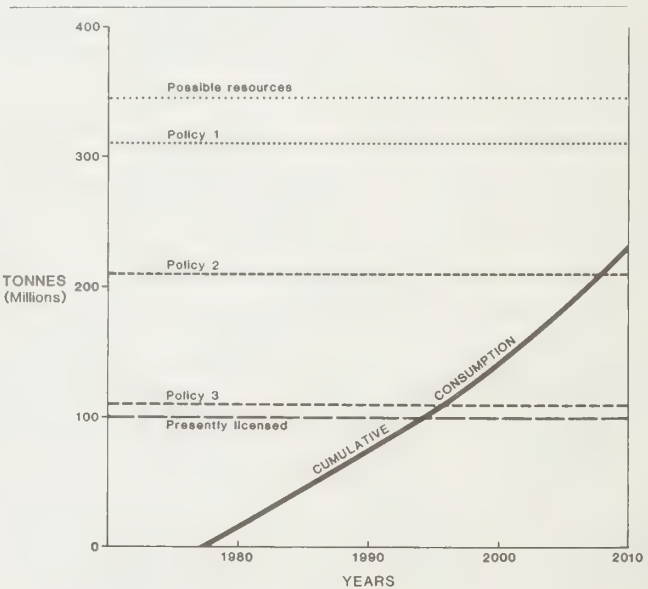
The delivered price of aggregates under the rail transportation option, which is the least costly of the long distance alternatives, would be \$7.60 per tonne at 1979 price levels; this would be almost twice as high as the average actual 1979 price of \$3.90. Under the long distance trucking option, the delivered price would be \$9.40.

The community impacts of aggregate extraction in the Saugeen area would be similar to the impacts of the system that would supply Toronto. The supply of London would add approximately 15 percent to the extraction area required for the supply of Toronto, e.g., about 1200 hectares.

The community impacts of the transportation routes to London would be worse than the impacts of the routes to Toronto. Since the volume of traffic would not justify the construction of new rights-of-way for a rail line, the existing CN lines would have to be used.



POSSIBLE RESOURCES - LONDON AREA



SUPPLY AND CONSUMPTION - LONDON AREA

Approximately two-thirds of the 135 km distance between the Saugeen and London areas consist of low-traffic branch lines that presently experience only a few short light trains per week. Aggregate transportation would add 7 long heavy trains per day (in both directions combined) to the present light traffic. The community impacts of these trains would be significant.

The location of the rail receiving terminal or terminals would present problems. London does not have a freeway network similar to that of the Toronto area. Thus, the concentration of distribution trucks in the vicinity of a relatively large rail receiving terminal would have worse effects than the present truck concentration in the vicinity of the existing dispersed production sites.

Since it was found in the evaluation for the Toronto area that the only significant advantage of long distance rail transportation would be the reduction of the harmful effects of local trucking, the lack of opportunity for such reduc-

tions in the London area would eliminate all the advantages of long distance rail transportation.

In the trucking option, the volumes would not justify the construction of a dedicated freeway and, therefore, trucks would use the existing road network. The traffic could be divided between two routes. On each of these the combined two-way truck volume would exceed 1,000 trucks on a peak day or 100 trucks in the peak hour. This means that approximately one aggregate truck would pass in each direction every minute through the communities along the roads throughout a distance of approximately 140 kilometres. The effects of these trucks would certainly be worse than the effects of truck movements under the option of continuing local supply, considering the much shorter travelling distances of that option.

It can be concluded that long distance transportation of aggregates by either rail or truck, would offer no advantages over continuing local supply for the London area.

Underground mining of up to one third of the aggregate requirements of the London area would be an attractive option for supplementing surface extraction, offering advantages similar to those found for the Toronto area, if local prices increased faster than inflation.



SUPPLY OF THE WINDSOR AND SARNIA AREAS

The estimated possible resources that would be available to the Windsor area under a range of licensing policies are shown in Figure 18. The quantities shown include substantial amounts of limestone that have either limited use because of quality problems or are owned by industrial interests that use the material for their own purposes but are currently not marketing it. For these reasons, in spite of the possible resources shown in Figure 18, the

Windsor area presently imports substantial quantities of stone by water from the United States. It is projected that the area will continue to rely on aggregate sources from outside the region.

The same is true for fine aggregates. Although supplies of sand are still available in the area, their life is limited and the area will probably have to rely on sand trucked from Michigan as the most economical source of supply.

Some sand is already imported today.

Figure 19 shows that if all the limestone resources were made available to the market, the Windsor area would have ample supplies for a long time to come. It would still be deficient, however, in fine aggregates.

The estimated possible resources available under a range of licensing policies to the Sarnia area are shown in Figure 20. As indicated, the area is deficient in coarse aggregates which are presently imported by water from the United States. It is projected that the area will continue to rely on the supply of stone from outside the area.

As indicated in Figure 21, the demand for fine aggregates could be supplied from sources inside the area during the next decade. Similarly to the Windsor situation an alternative source of supply is the trucking of sand from Michigan, which already occurs in limited quantities.

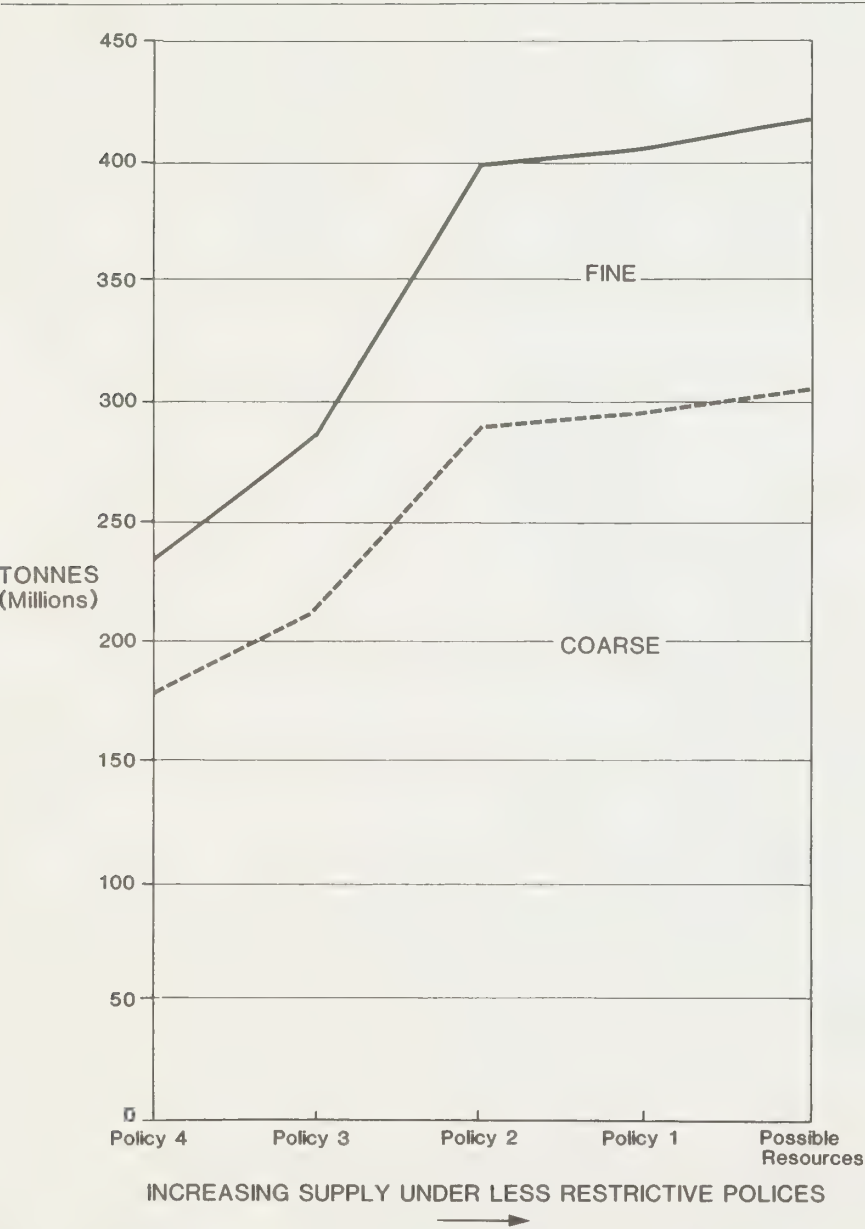
Supply Options

The most favoured long distance aggregate supply system for the Windsor and Sarnia areas would be the continuation of the present system. An alternative is to change the supply of crushed stone from Michigan to sources on Manitoulin Island. The supply would be by water, as shown in Figure 22.

It is estimated that the delivered price of aggregates would not change as the result of changing the supply source. The average delivered price of stone in terms of 1979 dollars would remain in the range of \$7.20 to \$7.65.

In the Windsor area, locally produced crushed stone could probably be marketed at a lower price but this option is not being currently pursued by the owners of the deposits.

The environmental impacts of quarrying stone on Manitoulin Island would be minimal since the quarries would be close to the ship loading docks and could be designed in a way that would minimize the impacts. The land for the quarries could be acquired in a normal commercial manner.



Existing docks in Windsor and Sarnia could handle the crushed stone delivered by ships and it would be distributed in the same manner as today. The distribution of 2 million tonnes of stone from several docks in Windsor and of 1.3 million tonnes of stone in Sarnia would not cause significant trucking problems provided that the docks are appropriately located.

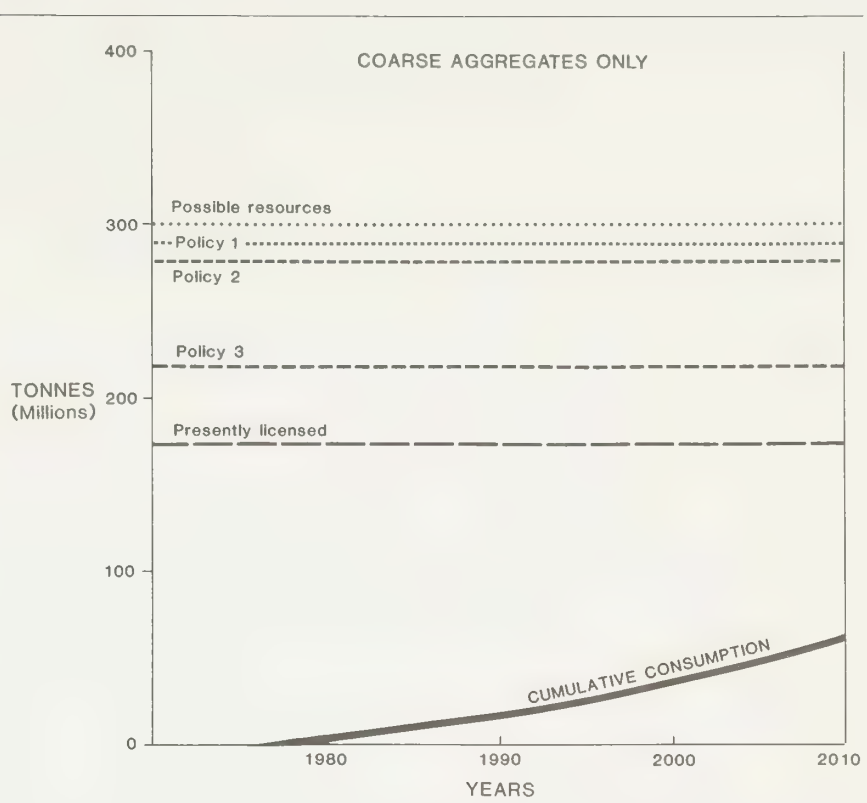
It was estimated that the peak truck traffic to distribute 1 million tonnes of aggregates per year would consist of approximately 20 loaded movements per hour. Such truck volumes normally represent small fractions of total traffic.

However, it was found that in Sarnia the present location of the aggregate docks and the associated traffic are considered a nuisance and a hindrance to the redevelopment of the waterfront – a project that is actively proceeding.

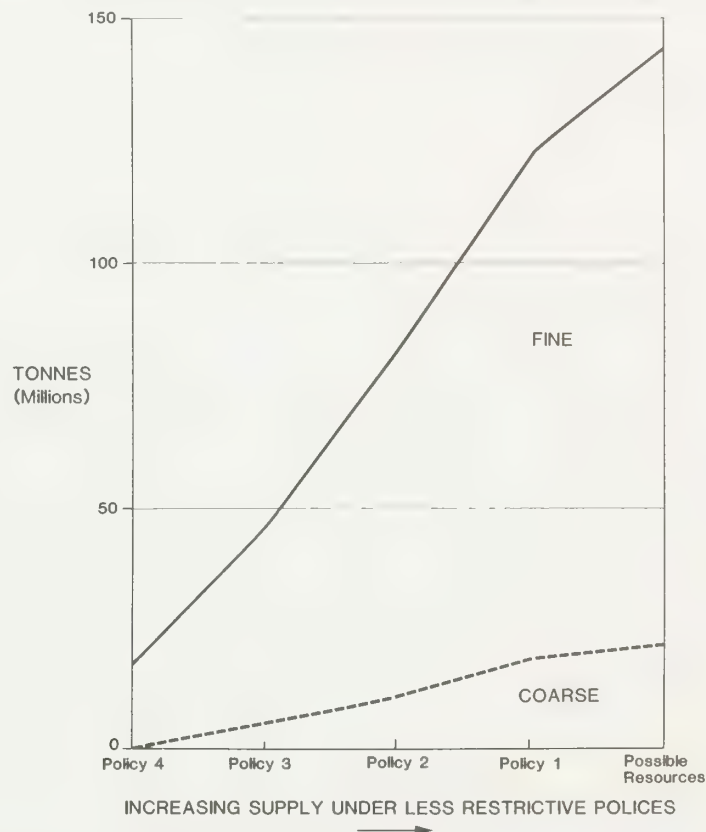
Fine aggregates required to supplement the crushed stone supply would be trucked within or into the Windsor and Sarnia areas from existing Canadian sources over short distances as long as the supplies last. As supplies of sand in the Windsor and Sarnia areas are gradually depleted the volume of sand imported from the United States is expected to increase. The trucks required to carry these amounts would not represent a significant fraction of the total traffic on the affected routes.

Fine aggregates from remote Canadian sources would not be competitive with imported sand and could only be looked upon as an emergency option should the supplies from the United States be disrupted for some reason. In that case, fine aggregates would have to be transported by rail at delivered prices that would exceed \$10.00 at 1979 price levels. The volumes would be relatively small and no special rail facilities would be justified beyond conventional loading and unloading terminals.

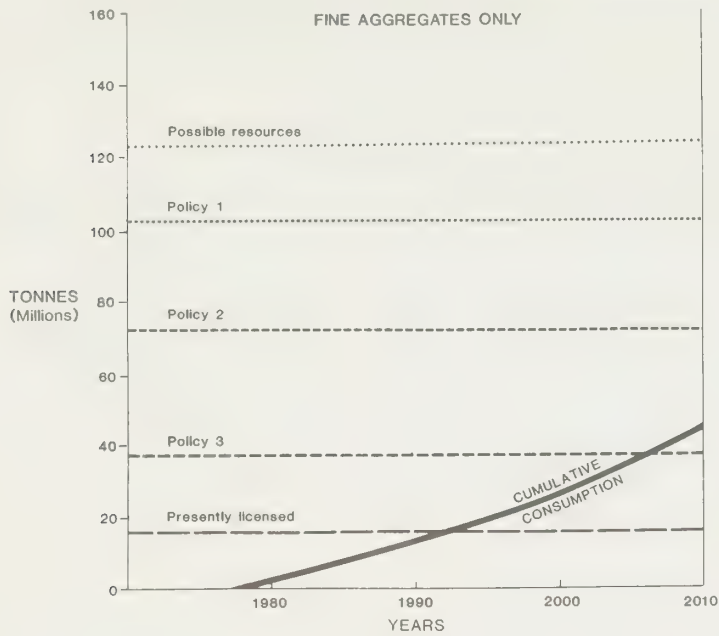
The additional traffic of at most 2 trains per day (in both directions combined) to Windsor and 1 train per day to Sarnia would not have significant environmental effects when considered in conjunction with other existing traffic.



SUPPLY AND CONSUMPTION - WINDSOR AREA



POSSIBLE RESOURCES - SARNIA AREA



SUPPLY AND CONSUMPTION - SARNIA AREA

21



SHIP ROUTE - MANITOULIN ISLAND TO SARNIA AND WINDSOR

22

CONCLUSIONS

Toronto Area

Present Provincial policies, related to the rehabilitation of aggregate production sites, mitigate the impacts of extraction on agricultural land and on the natural environment. Remaining impacts would not be less disruptive in such areas as Saugeen than near Toronto.

Local trucking of aggregates near the production sites still remains a serious problem in terms of impact on the communities. These were found to be the only harmful effects that could be eliminated by the long distance transportation of aggregates.

Even if the most preferred of the long distance transportation options, transportation of aggregates by rail from the Saugeen to the Toronto area was adopted, the added cost to the consumers would be at least \$100 million annually. Incremental investments amounting to more than \$400 million would be required and the fuel consumption of the system would be almost twice as high as that of a local supply system.

Long distance transportation of aggregates is not the only means of reducing the harmful effects of trucking on communities in the Toronto area. Other means that would likely be equally effective on long distance transportation would be:

- Construction of new access roads between aggregate extraction sites and major roads.
- Giving greater recognition in the Ministry of Transportation and Communications' municipal roads subsidy program for improving municipal roads used for aggregate haulage.
- Designating certain routes for aggregate hauling.

Gravel pit in operation



Rehabilitated gravel pit



- Enlarging the road surfacing program so that all roads used for significant aggregate haulage would be hard surfaced.
- Recognizing the special requirements for aggregate traffic in road improvement programs to minimize interference with other traffic; truck climbing lanes and improvements at intersections are examples of this.
- Maintaining and enforcing regulations related to the sizes, weights and speed of aggregate trucks.
- Considering new legislation to provide for additional control over the movement of aggregate vehicles to minimize the aggravation to adjacent residents and other motorists.

These improvements would cost the Provincial government money, either directly or through its subsidy program to municipalities. However, the alternative of long distance aggregate transportation would also cost the Provincial government money, since the Province and the provincially subsidized municipalities are major purchasers of aggregates. It is likely that the long distance option would actually cost more.

Thus, the savings by the private sector and by the unsubsidized municipal sector resulting from the continuation of local aggregates supply under improved traffic conditions would represent a net saving for the total economy.

London Area

Long distance transportation of aggregates does not offer any advantage for the London area since there is no free-way network similar to that of Toronto and, therefore, truck traffic near rail terminals would likely be more disruptive than near the present dispersed production sites. Long distance truck transportation would be even worse because it would extend the harmful effects of aggregate trucks to much longer routes.

The alternative solutions for reducing the impacts of local trucking through the direct improvements described in the summary for the Toronto area are fully applicable to the London area as well. In fact for the London area these measures appear to be the only ways in which the impacts of aggregate distribution could be reduced.

Windsor and Sarnia Areas

The most favoured long distance supply system for crushed stone to the Windsor and Sarnia areas was found to be the present system of water transportation. Alternatively, imported stone could be replaced by stone quarried on Manitoulin Island. This option was found to be economically feasible.

The most economical method of supply for fine aggregates would still be trucking from the United States. If that supply became infeasible for some reason, the alternative would be rail transportation from remote Ontario sources, but at substantially higher prices.

Rehabilitated gravel pit



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